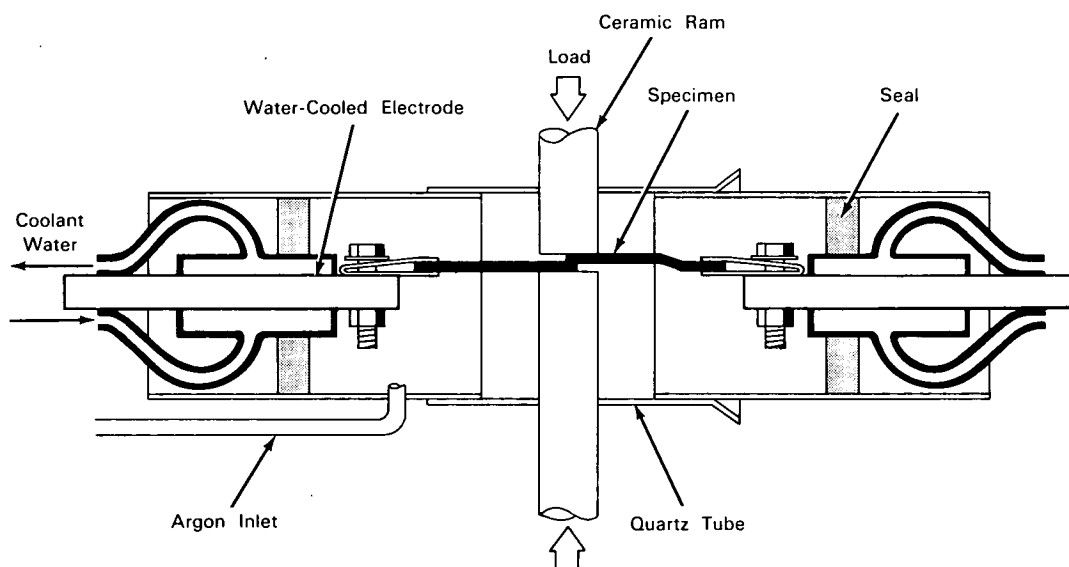


NASA TECH BRIEF



NASA Tech Briefs are issued by the Technology Utilization Division to summarize specific technical innovations derived from the space program. Copies are available to the public from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151.

Thoriated Nickel Bonded by Solid-State Diffusion Method



LABORATORY APPARATUS FOR DIFFUSION BONDING OF OVERLAPPED SPECIMENS

The problem: To develop a method of forming high-strength joints between butting or overlapping surfaces of thoriated nickel (a dispersion of 2% by weight of thorium in a matrix of nickel). Thoriated nickel combines the properties of good workability (ductility) with adequate strength and resistance to corrosion at elevated temperatures (up to 2,300°F). This material cannot be satisfactorily joined by conventional welding methods, however, because the inert thorium particles agglomerate in the weld area.

The solution: Solid-state diffusion bonding of the material in an inert-gas atmosphere. This method eliminates inert-phase agglomeration and produces a high-strength metallic bond.

How it's done: The areas of the specimens to be bonded are first cleaned with acetone and water and then brought into contact (overlapped as shown in the illustration of a laboratory setup). The contacting specimens (tack-welded by capacitor discharge at the corners of the overlap to maintain them in the proper relative position) are then placed in the bonding apparatus. Bonding is effected by means of direct resistance heating and application of a compressive load to the overlapping areas of the specimens. An atmosphere of argon gas is maintained in the apparatus during the bonding process in order to prevent oxidation of the base metal in the specimens. Compressive loads of 12,500 psi and 8,000 psi maintained for 1 minute at

(continued overleaf)

temperatures of 2,000°F and 2,150°F, respectively, produced joints capable of withstanding room-temperature shear stresses of up to 52,000 psi.

Notes:

1. The results of tests on thoriated nickel strips bonded by this method indicate that the joint strength is a linear function of the bonding pressure. Specimens bonded at 2,000°F, using a bonding pressure of 8,000 psi, exhibited a shear strength of 52,000 psi (approximately 93 percent of the base metal strength).
2. This method, using somewhat different processing parameters, also produced satisfactory bonding between thoriated nickel and a precipitation-strengthened nickel superalloy.
3. Bonding of the nickel composites subjected to mechanical pressure in a vacuum furnace requires 7 to 10 hours, as compared to a time of only 1 minute using the resistance-heating method in an argon atmosphere.

4. The resistance-heating method of bonding nickel composites should find industrial application in the production of components and structures for vacuum heat-treatment furnaces, heat exchangers, gas turbines, and other equipment which must operate at elevated temperatures.
5. Information concerning the properties of thoriated nickel is given in NASA TN D-1944, "An Investigation of a New Nickel Alloy Strengthened by Dispersed Thoria", by Charles R. Manning, Jr., Dick M. Royster, and David N. Braski, July 1963, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151; price \$1.00. Inquiries may also be directed to:

Technology Utilization Officer
Langley Research Center
Langley Station
Hampton, Virginia, 23365
Reference: B65-10220

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

Source: T. T. Bales and R. C. Manning, Jr.
(Langley-116)